A Detailed Analysis of Serious Personal Injuries Suffered by Full Time and Part Time Soldiers of the Australian Army

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Introduction

The Australian Army, similar to military units worldwide, is composed of both full time and part time soldiers [1]. To maintain optimal functioning of the military unit both the Australian Regular Army (ARA) and Australian Army Reserves (ARES) are exposed to the vigorous occupational demands of military service [2]. Military service is known to expose personnel in both populations to serious injuries, through activities including physical training (PT) and military operations [2]. In this context, a Serious Personal Injury (SPI) is defined as an injury which requires immediate in-patient hospitalization or immediate medical treatment, for example, serious lacerations or serious head, eye, or thermal injuries [3]. SPIs are a concern for the Army and its personnel, since they can reduce opportunity for deployment and detract from military readiness [4-6]. A criticism of the current body of literature pertaining to injuries is that many injury epidemiology studies do not separate injuries into their levels of severity and therefore the significance of serious injuries like these may not be sufficiently conveyed [7].

The training regimes of both part time and full time army personnel must match the relevant occupational demands, with the ultimate aim of training being the production of a combat ready soldier [8]. High intensity training is therefore required to match the high intensity tempo of operational deployment. PT in the military is known to involve conditioning approaches that include running, resistance training, battle training and loaded marches [6,9]. Examples of this high intensity training are evident in the Greek military, with their Battle Combat Training (BCT) running for over 12 hours [9]. Likewise, recruits on the Combat Infantryman's Course (CIC) in Britain have been reported to burn over 5000 kcals of energy per day [6]. Toward the end of basic training United States Army recruits have been reported to cover 12.8±5.8km during field exercises [10] , US Marines complete a 54 hour challenge comprised of mental, physical and moral challenges [11], while navy recruits are

evaluated while completing a ten hour event with critical and extreme training scenarios as the capstone of their basic training [12]. Often, the training intensity experienced in the military is far greater than what recruits have previously experienced [6] and the adaptation process to the physical demands of a military lifestyle can leave the body at risk of serious injury [13,14]. This is particularly evident in the fact that most injuries occur during the first 2 to 3 weeks of training [6,9,15].

Those enlisted in the military may be involved in a variety of operations, worldwide, with operations a known source of serious injury within the military. These operations often place soldiers in unfamiliar, hostile environments [16] in which they may be exposed to heavy lifting, loaded marches or dismounted patrol [5]. Additionally, active duty soldiers may be required to stress their bodies in both awkward and sustained postures as part of their occupational demands [5]. Other operational activities which have previously been reported to expose personnel to SPIs include motor vehicle accidents and direct contact with the enemy [17].

When SPIs occur, the individual cost can include a risk of medical discharge, permanent disability and long-term health problems [18]. In addition to costs to the individual, the cost to the military comes in the form of lost resources, lost training days and decreased force effectiveness [6]. Previous estimates are that musculoskeletal injuries may limit duty days in U.S. Army trainees, men and women combined, up to 14 times more than illness or disease. Due to the magnitude and impact of these SPIs, the rules are strict regarding the mandatory reporting of these incidents when they occur. Given the immense burden of SPIs within the military, the aim of this investigation was to analyse the incidence rates and patterns of SPIs which occurred within the Australian Army within a two-year period, with a view of informing future targeted interventions aimed at minimising these costly occurrences.

Methods

Data were obtained from the Australian Department of Defence's Work Health, Safety, Compensation and Reporting (WHSCAR) database (now SENTINEL), which is designed to capture details of workplace incidents, illnesses and injuries experienced by defence personnel. This data pertained to Army personnel who had experienced an incident, illness or injury within the two-year period 01 July 2012 to 30 June 2014 and was provided in a non-identifiable format, in an excel spreadsheet. Variables of interest for this study included service type (ARA or ARES) and the activity being performed, mechanism, body location and nature of reported injuries. Injury records were included in the final data set and analysis for this study if they pertained to an SPI, as defined above, sustained within the designated two-year period by ARA or ARES personnel. All illnesses, fatalities, near misses, exposures and minor personal injuries were excluded from the analysis, since the focus of this report was SPI. Also excluded were records of SPI sustained by any personnel from armies of other nations or by non-human (i.e. canine) members. Army population figures for the two-year period of interest were obtained through the Department of Defence [19,20]. Mean population sizes over the two-year period were 29 401 personnel for ARA and 15 034 personnel for ARES.

Ethics approval for this project was granted by the Australian Defence Human Research Ethics Committee (LERP14-024) and the Bond University Human Research Ethics Committee (RO1907).

In order to provide comparable indications of the numbers of SPI experienced by ARES and ARA members over the two-year timeframe, raw numbers of reported SPIs from 2012-2014 for ARA and ARES were divided by the total full-time equivalent of years of service provided to the Army by each service component (ARES and ARA), across the two

year period, and then multiplied by 100. This allowed for rates of SPIs to be reported in terms of *SPIs per 100 full-time equivalent (FTE) years of service*. To calculate the total FTE years of service provided by ARES personnel in the two-year study period, the following equation was used: Total days of active service typically completed in a full-time year of army service = 365d in a year – 104d weekends (or 'in lieu' non-service days) – 20d annual leave – 9d public holidays. Thus 232 days of active service were assumed to be equal to one full-time equivalent year of service. The actual number of days logged by ARES personnel (n=1 090 689 days) was provided by the Department of Defence. This meant the total full-time equivalent years of service for ARA was calculated at 58 802 and 4 701 for ARES.

The extracted WHSCAR data pertaining to SPIs affecting ARA and ARES personnel in the two-year period 2012-2014 were then entered into the Statistical Package for the Social Sciences (SPSS: IBM, USA Version 21.0) software for analysis. The analysis examined the incidence of SPIs amongst ARA and ARES personnel, and the incidences of SPIs associated with the most commonly reported types of: (a) activities; (b) mechanisms; (c) body locations; and (d) natures of injury. In addition, injury risk ratios (IRR) were calculated, where appropriate, by dividing the observed incidence of SPI in the ARA by the observed incidence in the ARES, with 95% confidence intervals (95% CI) around the population estimate of each IRR calculated as:

$$95\%\ CI = \exp(\ln[IRR] - 1.96 \times SE(\ln[IRR])) \text{ to } \exp(\ln[IRR] + 1.96 \times SE(\ln[IRR]))$$

where

$$SE(\ln[IRR]) = \sqrt{(1/[\text{incidencerateARES}] + 1/[\text{incidence rateARA}] - 1/n\text{ARES} - 1/n\text{ARA})}.$$

Results

A total of 12 065 Work Health and Safety incidents (including injuries, illnesses and other types of incident outcomes) were reported amongst ARA and ARES military personnel over the two-year period of the study (2012-2014). Amongst these recorded incidents, 734 (ARA, n= 668; ARES, n= 66) were defined as "Serious Personal Injuries or Illnesses". After removal of cases involving *illness*, the number of serious personal *injuries* totalled 507 (466 in ARA personnel and 41 in ARES personnel. Adjusting for total days of service, ARA personnel reported 0.79 SPIs per 100 full-time equivalent (FTE) years of service, and ARES personnel reported 0.87 SPIs per 100 FTE years of service. This resulted in an injury risk ratio (IRR; ARA:ARES) of 0.91 [95% CI 0.66-1.25], meaning that when adjustment was made for total days of service, ARES and ARA personnel reported very similar rates of SPI. The combined (ARA and ARES) injury rate was 0.80 SPIs per 100 full-time years of service.

Table 1 details the activities in which SPIs most commonly occurred. Overall, Combat Training was found to be the most common activity being performed when an SPI occurred (n=80, 16% of all SPIs), followed by Physical Training (n=66, 13% of all SPIs), and rates of SPI occurring in each of these activity types (adjusted for total days of service) were similar in ARA and ARES. In this context, manual handling or conducting manual tasks is one that requires a person to lift, lower, push, pull, carry or otherwise move, hold or restrain any person, animal or thing [21].

Of the 57 activity descriptors included in the SPI dataset, eleven represented various organised sporting activities. If these different sports were classified together, they would constitute the most commonly reported activity causing SPI amongst Australian regular army personnel (accounting for 85 SPIs, or 0.14 SPI/100 FTE years of service), with Rugby Union/League (n=22), Soccer (n=17) and Touch Football (n=14) featuring heavily as

activities which caused SPIs. There was only a single report of an SPI in sport in ARES personnel.

Table 2 shows the body locations in which SPIs occurred most frequently over the two-year period. The head (13% of ARA SPIs), shoulder (11% of ARA SPIs) and knee (10% of ARA SPIs) were the most commonly locations in which a SPI occurred in ARA personnel, while the shoulder, knee and lumbar spine (each 10% of all ARES SPIs) were the most commonly injured body locations in ARES personnel. Many of the head injuries in the full-time cohort were blast related injuries due to improvised explosive devices (IED) whilst on deployment or concussions related to playing sport. Overall, the body locations most often affected by SPIs were similar between ARA and ARES personnel.

The most common natures of SPIs reported by ARA and ARES personnel are seen in Table 3. ARA personnel most commonly suffered fractures (24% of ARA SPIs), soft tissue injuries (20% of ARA SPIs) and dislocations (12% of ARA SPIs), while ARES personnel most commonly suffered similar types of SPI, though rates varied slightly.

The most frequently reported mechanisms of SPI for both ARA and ARES personnel are indicated in Table 4. Falls were found to be the most common mechanism of SPI in both ARA personnel (26% of ARA SPIs) and ARES personnel (27% of ARES SPIs), followed by contact with moving or stationary objects (22% ARA: 27% ARES). Again, overall the most common mechanisms of SPIs were similar between ARA and ARES personnel.

Discussion

The aim of this investigation was to analyse the incidence rates and patterns of SPIs amongst both full time and part time soldiers of the Australian Army. The results from this study suggest that, once incidence rates are adjusted for days of service, part time (ARES)

personnel report SPIs just as frequently as their full-time (ARA) colleagues, with both groups reporting similar adjusted SPI incidence rates.

Combat Training and Physical Training were found to be the most common activities being performed when a SPI occurred. These two activities were also the most common sources of injuries observed in research conducted in military forces of other nations [22,23] and for Minor Personal Injuries [24], for basic training injuries [14], and for incidents, near misses and exposures [25] within the Australian Army more broadly. It has been postulated previously that part time personnel may be at greater risk of injury during combat training due to less chronic conditioning and less opportunity to be exposed to it outside of military duties [26]. Previous research has also suggested that part time personnel may be less fit than their full time colleagues [27], increasing their risk of injury [28,29].

Of concern may be the high number of SPIs due to vehicle accidents, particularly in the ARA, where these accounted for 71 (15%) of 466 SPIs. This finding is similar to findings in the U.S. military, where vehicle accidents were found to be responsible for 12-16% of US non-battle casualty evacuations during the Iraq and Afghanistan wars [30]. It is unclear whether this is due to the vehicles which are operated, the terrain in which they are operated, the operational circumstances in which they are operated, or a combination of all three. Despite the similarities, efforts should be made to identify and implement strategies to reduce the number of vehicle related SPIs within this group. The observed disparity between ARA and ARES personnel in the rates of SPIs sustained during operational combat may be due to the more limited opportunities for part time personnel to be deployed on combat operations. This difference may also explain in part the higher numbers of SPIs affecting the head, in ARA personnel. However, the higher rates of head injuries may also be explained in part by the encouragement of sporting activities in the full-time military and minimal opportunities for

participating in Defence sport for part-time personnel [24]. As noted in the findings of the current study, sport is a common source of injuries in the military [31,32], with previous estimates suggesting that sports related injuries cost the United States military 29 435 lost duty days per year [31]. Nevertheless, explosion or blast injuries have been reported to be the most common type of war injury, occurring more commonly than penetrating brain injuries [33]. The significance of these injuries is highlighted by the fact that those with mild blast injuries have an increased risk of developing Post Traumatic Stress Disorder [33], a debilitating disorder, the prevalence of which is estimated to be between 10-20% of returning service members [34].

Research shows that while overuse injuries tend to be more common than traumatic injuries, fractures, knee ligament ruptures and dislocations tend to account for more service days lost [23]. Fractures, which were a very common type of SPI observed in the current study, are a leading cause of hospitalisation among United States military personnel [35]. The knee has been reported as the most commonly injured area in both the Australian military [26,29] and in international forces [28,36,37], and was again prominent here as a site of injury. The low back, another common site of SPI in this study, is also a common site of injury in the military generally [35,38,39], with some reports highlighting its prevalence particularly amongst female soldiers performing physical training [17].

The common mechanisms of injury for SPI were similar for both service types in the current study, and again consistent with findings of previous research in U.S. military populations [35,40]. SPIs resulting from falls were common in both service types, consistent with previous studies strictly examining fall-related hospitalisations [41]. Likewise, the high prevalence of falls and vehicle accidents is consistent with other research focusing on non-battle related incidents amongst US army members while on active duty in Iraq and Afghanistan [40].

A noticeable limitation of this study was the relatively small numbers of SPI observed in ARES personnel, which affected the precision of estimates of incidence rates of SPI in ARES personnel. This limitation made it difficult to compare rates of SPI between ARA and ARES components, particularly when comparisons were cross-tabulated across more than one variable. Another main limitation of the study was a result of the WHSCAR data recording. It was not possible to report usefully on data that was entered into "other" categories. This was predominantly evident when SPIs were reported as being due to "other and not specified" activities and mechanisms reported under "other and multiple mechanisms of incident". Likewise, the nature of this reporting system, in which the individual is required to report their injuries retrospectively, has drawn criticism [42], with a point-of-care reporting system for injuries being proposed to more comprehensively capture reports of injuries within this population. Finally, it is worth reiterating that this paper was focused on SPI only and none of the findings should be assumed to be indicative of injuries of other levels of severity.

Conclusions

Full time and part time army personnel were found to suffer similar rates of SPIs, once rates were adjusted for annual exposure to military service. SPIs were found to occur most commonly during physical training and combat training, with these outnumbering SPIs which occurred during operations. Future research is needed to examine the utility and effectiveness of evidence-based interventions aimed at reducing SPIs among full-time and part-time soldiers.

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